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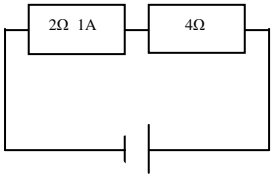
Physics worksheet solutions – Series and parallel circuits **(Assume zero internal resistance for the batteries)**

Q1 Determine (i) the current through the battery, (ii) the voltage of the battery.



Series circuit:

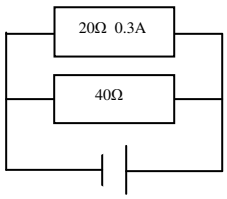
(i) $I_{battery} = 1\text{ A}$

(ii) $V_{2\Omega} = IR = 2\text{ V}$,

$V_{4\Omega} = 4\text{ V}$,

$\therefore V_{battery} = 2 + 4 = 6\text{ V}$

Q2 Determine (i) the current through the battery, (ii) the voltage of the battery.



Parallel circuit:

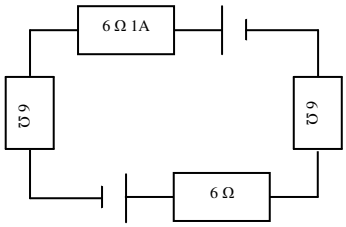
(i) $I_{40\Omega} \times 40 = 0.3 \times 20$,

$\therefore I_{40\Omega} = 0.15\text{ A}$

$I_{battery} = 0.3 + 0.15 = 0.45\text{ A}$

(ii) $V_{battery} = V_{20\Omega} = 0.3 \times 20 = 6\text{ V}$

Q3 The two batteries are identical. Determine (i) the current through each battery, (ii) the voltage of each battery.



Series circuit:

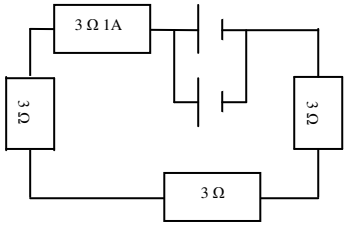
(i) $I_{battery} = I_{6\Omega} = 1\text{ A}$

(ii) $V_{6\Omega} = IR = 6\text{ V}$

$Total = 4 \times 6 = 24\text{ V}$

$V_{battery} = \dfrac{24}{2} = 12\text{ V}$

Q4 The two batteries are identical. Determine (i) the current through each battery, (ii) the total power of the batteries.



The batteries are connected in parallel. The resistors are in series with the batteries.

(i) $I_{battery} = \dfrac{1}{2} \times 1 = 0.5\text{ A}$

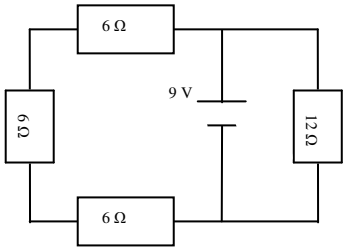
(ii)

$V_{battery} = 4 \times (1 \times 3) = 12\text{ V}$

$P_{total} = VI = 12 \times 1 = 12\text{ W}$

Q5 Determine (i) the current through each resistor, (ii) the potential difference across each resistor, (iii) the power supplied by the battery.

The 12Ω resistor is parallel to the series of 6Ω resistors and the battery.



(i)

$I_{12\Omega} = \dfrac{V}{R} = \dfrac{9}{12} = 0.75\text{ A}$

$I_{6\Omega} = \dfrac{9}{18} = 0.5\text{ A}$

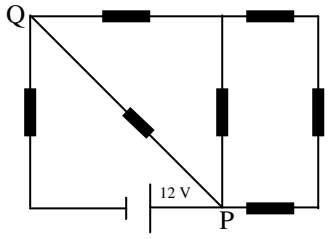
(ii) $V_{12\Omega} = 9\text{ V}$, $V_{6\Omega} = 3\text{ V}$

(iii)

$I_{total} = 0.75 + 0.5 = 1.25$

$P = VI = 9 \times 1.25 \approx 11\text{ W}$

Q6 The seven resistors are 10 Ω each. The voltage of the battery is 12 V. Determine (i) the current through the battery, (ii) the potential difference between P and Q.



(i) $R_{total} =$

$$10 + \frac{1}{\frac{1}{10} + \frac{1}{\frac{1}{\frac{1}{10+10+10} + \frac{1}{10}} + 10}} \approx 16.4$$

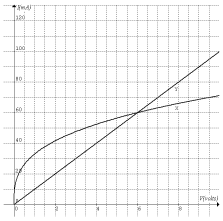
$I_{battery} = \dfrac{V}{R} = \dfrac{12}{16.4} \approx 0.73\text{ A}$

(ii) For the 10Ω on the left

$V = IR \approx 0.73 \times 10 = 7.3\text{ V}$

$V_{PQ} \approx 12 - 7.3 = 4.7\text{ V}$

Q7 The I-V characteristics of two electronic components X and Y are shown below. They are connected with a power supply. Find the potential difference across each component when they have the same resistance.



Same resistance, .: same current and potential difference.

$V_X = V_Y = 6\text{ V}$

Q8 Refer to the two components in Q7.

(i) The voltage across X is 3.5 V when they are in series with a battery. What is the voltage supplied by the battery?

(ii) The voltage across X is 8.0 V when they are parallel to a battery. What is the current through the battery?

(i) Series connection, same current 50 mA, $V_Y = 5.0\text{ V}$

$\therefore V_{battery} = 3.5 + 5.0 = 8.5\text{ V}$

(ii) Parallel connection, same voltage 8.0 V, $I_X \approx 66\text{ mA}$,

$I_Y = 80\text{ mA}$, $I_{battery} \approx 66 + 80 \approx 150\text{ mA}$

Q9 Refer to the two components in Q7. (i) If they are connected in series with a 3-V battery, what is the current through the battery? (ii) If they are connected parallel to a battery and the current through the battery is 100 mA, what is the voltage of the battery?

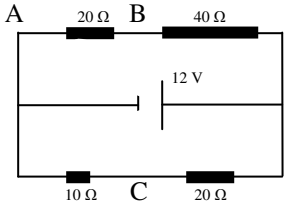
(i) Estimated from the graph, when $I_X = I_Y \approx 25\text{ mA}$,

$V_X \approx 0.5$, $V_Y \approx 2.5$, $V_{battery} \approx 3.0\text{ V}$. $\therefore I_{battery} \approx 25\text{ mA}$

(ii) *Estimated from the graph, when* $V_X = V_Y \approx 4.5\text{ V}$, $I_X \approx 55$,

$I_Y \approx 45$, $I_{battery} \approx 100\text{ mA}$. $\therefore V_{battery} \approx 4.5\text{ V}$

Q10 Determine the potential difference between (i) A and C, (ii) B and C.



(i) $V_{10\Omega} = \dfrac{10}{10+20} \times 12 = 4\text{ V}$

$\therefore V_{AC} = 4\text{ V}$

(ii) $V_{20\Omega} = \dfrac{20}{20+40} \times 12 = 4\text{ V}$

.: B and C have the same potential, $\therefore V_{BC} = 0\text{ V}$